# CHARACTERISTICS OF THE TAYLOR MARL
# OF TRAVIS COUNTY, TEXAS

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THESIS

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# INTRODUCTION

Although the Taylor formation has been known and recognized as a definite division in the Gulf Series of the Cretaceous from an early date of geological investigation in Texas, it has not been seriously studied in detail by the student of geology. It was through the realization of this fact, and also due to the hope that a study of both the stratigraphy and faunal remains might be of benefit to the profession, that the assignment was accepted for investigation, the results of which are herein presented.

The object of this thesis is to present in as brief and as logical a manner as possible, yet exhaustively, the data collected on this subject during a period extending over some three years, and to interpret this data as accurately as its nature will permit.

This will necessarily entail a description of the formation as to stratigraphy or sedimentation as well as to outstanding fossil horizons. Furthermore, it will be advantageous both to the reader and the writer to discuss the faunal remains under two separate divisions, those of macroscopic and those of microscopic character, each in conjunction with the related stratigraphic changes in the formation.

Acknowledgements

The writer is gratefully indebted to Professor F. L. Whitney, of the Geological Department of the University of Texas, for valuable instruction, encouragement, helpful suggestions, and for the greatly needed supervision of the work in its various details.

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The writer also wishes to thank the Bureau of Economic Geology, of the University of Texas, for the use of a set of their samples from the R. R. Penn-Hardy #1, an oil well drilled in Bell County, Texas.

## NATURE OF THE FORMATION

The Taylor formation of Travis and adjoining Counties, throughout most of its section of 550 feet, more or less, is a massive unctuous blue marly clay which weathers to a brownish-yellow color due to the contained iron compounds. Locally, this clay is called "joint clay" due to its characteristic jointing or cracking into irregular blocks when seen in a fresh exposure. When freshly exposed, the formation is dark blue or blue-black, and shows no evidence of stratification, but when weathered slightly, most of the section shows definite stratification marks.

The Taylor marl disintegrates rapidly, and when subjected to long continued weathering it soon erodes into low rounded hills and shallow drainage channels

Characteristic Taylor marl topography

forming a rolling prairie country covered with a luxuriant growth of vegetation. Consequently, considerable outcroppings of fresh exposures are rare.

The Taylor marl is easily distinguished from the underlying conformable massive chalky-white Austin limestone, but it differs from the Navarro clays above only in that the Navarro clays contain much more sand and a mineral called glauconite which causes it to weather to a greenish-yellow color. Glauconite is not present in the Taylor formation in quantities large enough to be detected in the field, and sand is present in an inappreciable amount.

## DRAINAGE

Most of the major streams of the Gulf Coastal Plain are maintaining themselves at grade and meander with a sluggish current. The Colorado River is no exception to this rule. It bisects the area studied and flows at right angles to the strike of the formations. The general elevation of the country varies slightly from 500 feet so that the tributaries to the Colorado also have a gentle gradient. All but the extreme north-eastern portion of the area is drained by the Colorado and its tributaries, this portion being drained by the tributaries of the San Gabriel River in Williamson County.

## STRUCTURE

Regional structure - The Taylor marl out-crops in Travis County in a band about six miles in width, running from the northeast corner of the county in a southwesterly direction to its south line between Creedmore and Manchaca Springs as shown on the accompanying map. Where the formations have not been disturbed by faulting, the area has a regional dip of slightly more than one degree to the southeast.

Due to the fact that the area under consideration lies between the Balcones and the Mexia-Luling fault zones, on the down throw side of the Balcones fault, it is considerably broken by faults paralleling the trend of the major fault systems.

This disturbance extends over the entire area, even as far east of the Balcones fault line as Bastrop, Texas.

Faulting and other structure affecting the section of the formation - On account of the faulting encountered in the Taylor section, it has been, up to this time, exceedingly difficult to arrive at a definite conclusion as to the exact thickness of the different stratigraphic and fossil horizons encountered. With the aid of the logs of two recently drilled wells, however, many of the doubtful features of this phase of the problem, it is felt, have been somewhat explained.

As shown on the accompanying map, at Manchaca Springs, about two miles north of Buda on the Buda-Austin highway, a zone of considerable faulting is exposed. This zone is at least one-fourth of a mile in width and extends, as shown, north-eastward to the east edge of the city of Austin, whence it is possible to trace it north-eastward to Pecan Spring where a similar zone of faulting is encountered in the bed of the creek just north of the bridge on the highway from Austin to Manor. Farther northeastward in the west bank of Little Walnut Creek, one-fourth of a mile north of the Austin-Manor Highway, it is again exposed.

At Manchaca Springs, the fault has a total displacement, to the east, of a little more than one hundred feet as shown on the profile figured in the Austin Folio by Hill and Vaughan. This condition makes a faulted contact between the Austin chalk and the Taylor marl. The throw to the east decreases toward Pecan Spring where the displacement is approximately thirty feet. At Little Walnut Creek the displacement is about twenty feet.

The next indication of faulting is near the middle of the Taylor outcrop, at Blue Bluff on the north side of the Colorado River, at Hornsby's Bend, about six miles east of Austin. At the east end of Blue Bluff there is a zone of jointing about one hundred yards wide, which gives rise to numerous springs flowing from the gravel above the clay exposure. It is believed that the displacement is to the west because of the westward dip of the strata up the River from the zone of jointing.[1] This dip was estimated to be slightly less than one degree. It was also found that this dip increases nearer to the zone of jointing. The strike of this jointing is approximately N. 55° E., which lines up with the strike of other jointing at the west end of Del Valle Bluffs in Sneed's Creek two miles southwest of Blue Bluff. It is evident that the course of the river between these two points is influenced by this reversal since the usual southeast flow is abruptly changed at Blue Bluff to the southwest until it reaches the west end of Del Valle Bluffs.

At a point beginning at Sneed's Creek on the south bank of the Colorado River and extending along the river to a point about one mile east of a north and south line through Del Valle Post Office, there is an exposed bluff of Taylor marl averaging thirty feet

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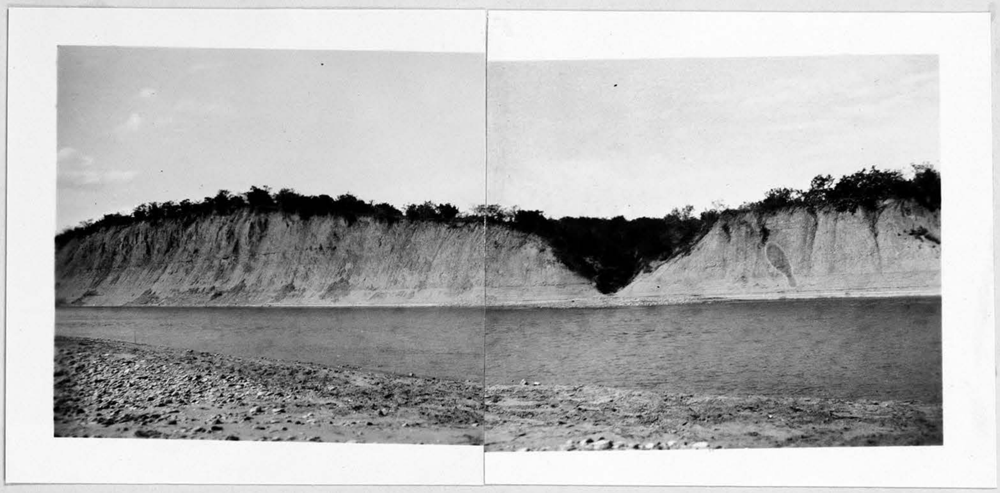
1. See Photograph on page 8.



Blue Bluffs showing ferruginous
layers in the Taylor marl
which have a west-
ward dip.

in height. This exposure is known as the Del Valle Bluffs. At the fartherest west end of these bluffs, the dip of the strata is approximately the same as the normal southeast dip of the region, being about one degree. This dip holds constant for about one mile down the river, then the strata dip sharply, about three degrees, to the east into a large fault having at least seventy feet of displacement to the east. This faulted area is about one hundred feet wide, and within it the strata dip at a steep angle of $45^{\circ}$ to the east. These strata are broken at short intervals allowing each succeeding higher segment of the tilted area to settle back a few feet.

to the west. From this point for a mile eastward to the eastern extremity of the Del Valle Bluffs exposure, there is no other evidence of faulting or dip. The massive blue clay in this part of the exposure had no noticeable stratification marks whatever.

The Del Valle Bluffs fault

In trying to determine the contact of the Taylor marl with the Navarro clays, a line of faulting was encountered extending from a point about one-quarter of a mile west of Kimbro, on the Austin-Manor Highway, towards the mouth of Onion Creek. Two and three-fourths miles north of Dunlap, and one-half mile west of the Dunlap-Manor Road, in a cultivated field, a fault was encountered which had a strike of N. 30° E. This strike projects into the faulting at Kimbro and is believed to be the same fault. The throw of this fault is between two hundred and two hundred and fifty feet to the east, which in most exposures along that line causes a faulted contact between the Taylor and the Navarro formations.[2]

In the compilation of the data collected in the field for the construction of the geological section, the faulting described above was necessarily taken into consideration.

## GEOLOGIC SECTION

Austin-Taylor contact zone - The best exposure of the contact of the Taylor with the Austin formation was encountered in Little Walnut Creek, about six miles east of Austin on the road to Manor. This contact is well exposed both north and south of the bridge. If one walks about a half mile, either up or down the creek, north or south of the bridge, one will

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2. See discussion, paragraph 2, page 30.

find a twenty-five foot section of massive dark blue unctuous calcareous clay in the creek bank resting conformably on top of the blue-white Austin chalk or limestone. Except that there is a stratum of rather coarse textured, somewhat fissile, blue chalk, from one to two feet in thickness, separating the two, the change is abrupt from white hard chalky limestone to the massive blue marl. Comparatively speaking, this stratum is outstanding for the abundance of Exogyra ponderosa contained therein. There is also an abundance of other pelecypods associated with these. The E. ponderosa extends upward

View of the Austin-Taylor contact.

into the Taylor marl for one hundred feet or more, and the specimens found there are developed to a much larger size than any found in the Austin chalk. The largest specimen of this species was found in Little Walnut Creek about one mile northwest of the road. This specimen measured seven inches across the flat valve.

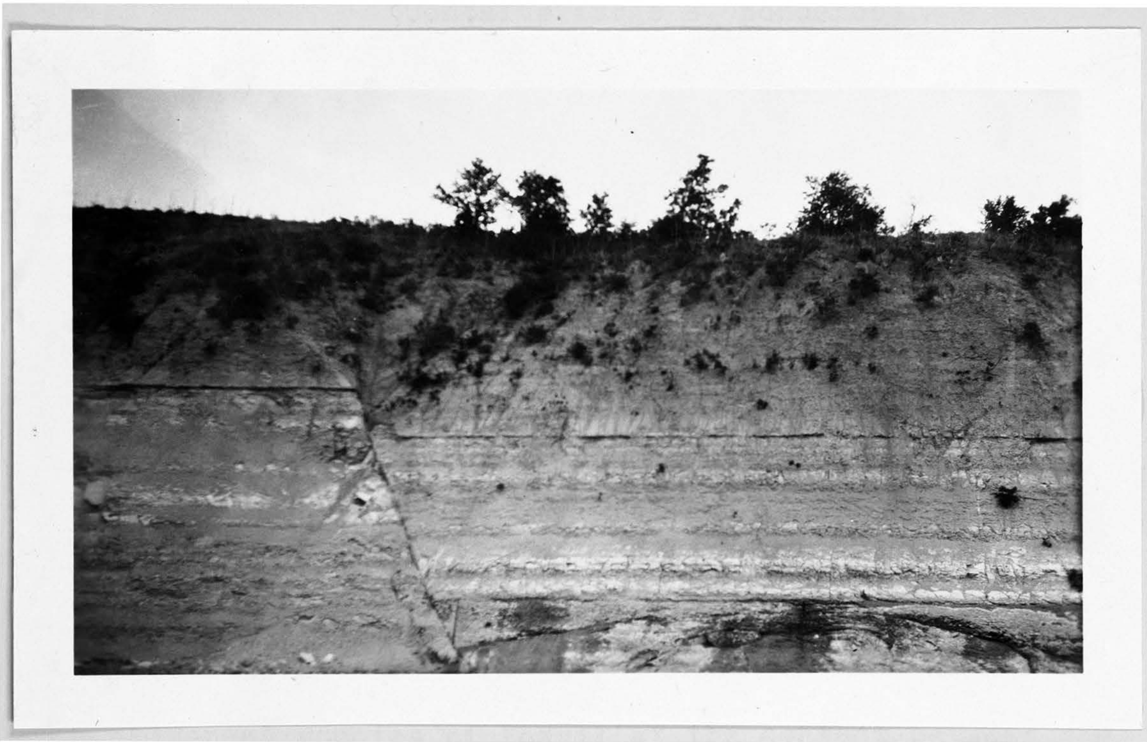
Starting in the top of the fossiliferous chalk just mentioned, the Ostrea falcata makes its first appearance. O. falcata accurs commonly throughout the Taylor section, and it is believed that with the abrupt change of lithology - from the typical Austin chalk to the typical Taylor marl, the appearance of O.falcata, and the large specimens of the E. ponderosa, the opening of the true Taylor marl times is indicated.

At Manchaca Springs the Austin-Taylor contact is hidden on account of the faulting described above under STRUCTURE. At other points along this faulted contact between Austin and the Manchaca Springs locality, the same condition was found to exist, and in order to find more data on this part of the section, it was necessary to study other localities outside of Travis County. In Williamson County, on the San Gabriel River, near Jonah, and on Brushy Creek near Hutto, some excellent exposures of the upper Austin and the lower Taylor formations were found.

At the former locality, which is one mile east of Jonah on the San Gabriel River, the same type of lithological transition from Austin chalk to Taylor marl was observed as at Little Walnut Creek in Travis County, except that the San Gabriel River section was found to contain more lime. The same association of fossils was found, and the following is a description of the section found at this locality.

At Jonah the concrete bridge across the River is laid on massive beds of typical Austin chalk. One-half mile south of this crossing, a hill of white chalk may be seen to the east about one hundred yards from the main road. This chalk contains an abundance of E. ponderosa, specimens of which vary from an eighth of an inch to four inches across the flat valve. This hill is the beginning of a low-lying, north-facing escarpment which extends eastward for about a mile. In following this escarpment, one finds that the exposed chalk beds contain E. ponderosa in abundance and character similar to the first outcrop examined. At the distance of about three-fourths of a mile along this escarpment, the E. ponderosa in general become larger in size as the chalk grades gradually upward into a softer chalk which weathers to a light yellow color. One mile east of the Jonah-Hutto Road, at the top of one of the low-lying hills, on the west side of a narrow draw through which there is a small flow of water, the abundance of E. ponderosa decreases and the chalk changes abruptly into a marly clay. The Exogyras found in these exposures are of the angular type common to the Austin chalk. Simultaneous with this change in lithology, the O. falcata makes its first appearance. As at Little Walnut Creek, specimens of E. ponderosa found in the typical Taylor marl above this change are scarce. They are, however, larger and more rounded than those found more abundantly in the chalk below.

A bearing of N. 40° E. from this point to the east end of the bluff on the river, about one-half mile away, gives the approximate strike of the formation in this locality. But the lower beds exposed in this bluff contain O. falcata and occasionally a large speciman of E. ponderosa, which indicate that the contact zone just described lies beneath the river bed. From this bluff up the river as far as the bridge where the massive Austin chalk is exposed, the sediments are covered with alluvium. The bluff exposure has a decided Taylor aspect except that the sediments at the base are very calcareous and are harder. This argillaceous chalk, however, shows the Taylor marl jointing, and it also exhibits its characteristic rapid disintegration when exposed to the elements, weathering to a yellowish-brown color at the top of the cliff.



The San Gabriel River exposure one mile
east of Jonah, Texas.

This outcrop extends only three-fourths of a mile down the river where the sediments are again covered with alluvium. The following section was measured at this bluff.

Section on the San Gabriel River One Mile East of Jonah, Texas

| Height above river bed | |
|---|---|
| 28.5 to 50' ----- | 22 feet of blue calcareous clay weathering to a brownish-yellow. Contains large *E. ponderosa*. |
| 28 to 28.5' ----- | 6 inches of hard brown arenaceous limestone having Fucoidal markings. |
| 0 to 28' -------- | 28 feet of massive light blue argillaceous chalk containing *E. ponderosa* and *O. falcata*. Alternating hard and soft strata of argillaceous chalk. |
| 0 --------------- | Water level. |

At the second locality, on Brushy Creek, directly south of Hutto, Texas, a section was found which contains a different species of fossil at the contact between the two formations than had hitherto been found in any of the other sections. This has been identified as *Gryphaeaostrea sp.* which resembles *G. vomer* (Morton)[3]

3. Stuart Weller. Cretaceous paleontology of New Jersey: Geol. Surv. of New Jersey, Vol. IV, 1907; p. 455, Pl. XLIV.

and occurs in the transition zone with the first appearance of *O. falcata*. An approximate section was run from the creek bottom beneath the bridge to the top of the hill in the road east of a two story farm-house as follows:

Brushy Creek Section South of Hutto, Texas

| Height above creek bed | |
|---|---|
| 110 to 115' ----- | 5 feet of black soil. |
| 101 to 110' ----- | 10 feet of yellow calcareous clay contains *O. Falcata*. |
| 100 to 101' ----- | 1 foot of yellow chalky clay containing an abundance of *Gryphaeaostrea sp.* with a few specimens of *O. falcata*. |
| 90 to 100' ------ | 10 feet of white nodular chalk. *E. Ponderosa* less abundant than below. |
| 75 to 90' ------- | 15 feet of white, nodular chalk highly impregnated with *E. ponderosa* varying in size from an eighth of an inch to four inches across the flat valve. |

60 to 75' ----- 15 feet of white nodular chalk
highly impregnated with
Gryphaea aucella.

0 to 60' ------ 60 feet of white massive chalky
limestone containing, at the
base, remains of Gryphaeas,
Ammonites, Nautili, Exogyras,
etc. These beds, from two to
ten feet in thickness, are
separated by thin partings
of blue-black, fissile shale.
This part of the section grows
more argillaceous in its upper
ten or fifteen feet.

0 ------------ Water level.

The peculiar Gryphaeaostrea zone noted in the top of the section above was again discovered in an exposure on an east-facing hill just west of a farm-house one mile east of the road where the above-mentioned section was found, and one-half mile south of the creek. It was also in this exposure that the O. falcata was found, making its appearance just above the Gryphaeaostrea sp. Approximately northeast from this hill, a fault in the creek bed brings the white Austin limestone in vertical contact with the massive blue clay typical of the basal Taylor marl, which clay contains O. falcata and E. ponderosa. The strike of this fault is N. $10^{\circ}$ E. with the downthrow to the southeast thus hiding from view the contact zone exposed on the hill. The contact is evidently faulted between twenty and fifty feet beneath the surface.

This is the only locality found where the Gryphaeaostrea zone crops out either in Travis or Williamson Counties, and its absence in other places is possibly due to the irregularity in depth of the sea floor of Austin chalk at the time of the transition from Austin to Taylor, or to a difference in water contents, or to both.

Basal Exogyra zone - From the base of the Taylor, extending upward for one hundred feet in the section, massive beds of typical blue Taylor marl were encountered. This clay has a high percentage of calcium carbonate, is apparently unlaminated (except in outcrops long exposed to weathering) and is not exceptionally fossiliferous. This part of the section, however, does contain frequent specimens of the E. ponderosa which are developed to an exceptionally large size, in some instances being as large as seven inches across the flat valve as previously mentioned.

At Manchaca Springs no speciments of the E. ponderosa were found in the Taylor which indicates that the fault at that place has a throw of more than one hundred feet. Northeastward along this fault, which is indicated on the map, more and more of the E. ponderosa zone is found until, at a point between Little Walnut and Walnut Creeks, and east of them, the full hundred-foot section is encountered.

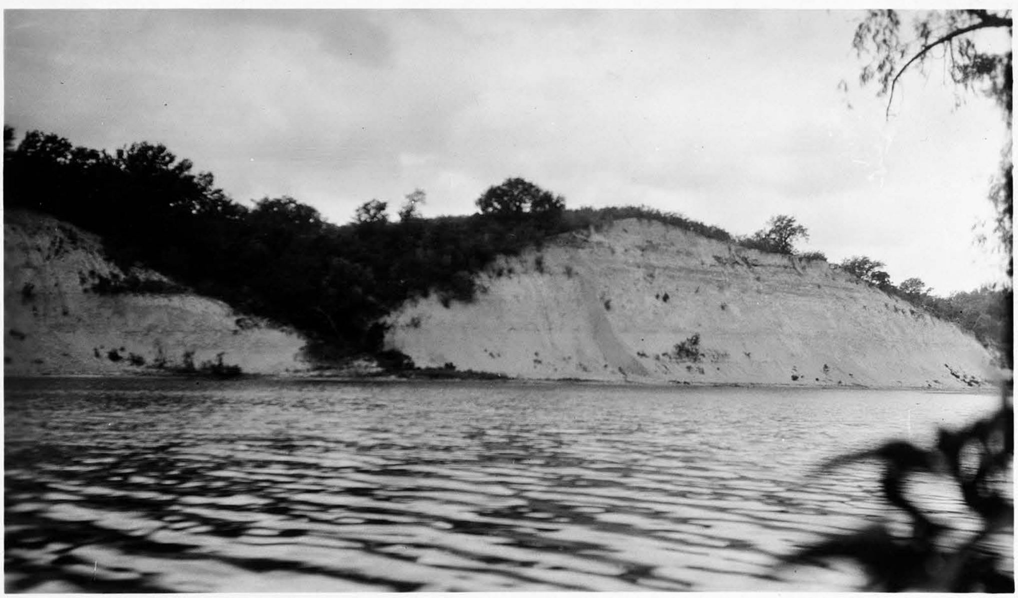
At or near the top of this hundred-foot section, a much more fossiliferous zone of a few feet in thickness was encountered. This zone is located on the Austin-Manor Highway in the road cut east of Walnut Creek, beginning at the M. K. & T. R. R. and extending to the top of the hill to the east. Near the middle of the cut, a one-foot layer of clay contains an abundance of Baculites ovatus casts, and above this for a few feet, the unctuous marly clay contains several other species such as the Nautilus sp, Exogyra ponderosa, small fragile pelecypods, small Ammonites, etc. Farther above this zone, the E. ponderosa is absent.

Blue Bluff and Del Valle Bluffs section - From the top of this *E. ponderosa* zone, a two hundred and seventy-five-foot section of the Taylor marl has the same character stratigraphically, but it is almost barren of large fossils except for the presence of the *Inoceramus sp.*, and *O. falcata*, which are present throughout the Taylor section.

There is one Stratigraphic feature present in this section not found elsewhere in the Taylor marl. This feature may be seen in Blue Bluff and Del Valle Bluffs. These exposures extend northwest and southeast so that the dip of the strata to the southeast is shown in them. At the base of Blue Bluff, several bands of ferruginous material are present. These bands are usually from two to three inches in thickness and weather to a ferruginous color. The material is a mixture of gypsum, calcite crystals, and iron pyrites, the latter causing the redish-yellow color when it is oxidized by exposure to the atmosphere. The ferruginous layers are also present in the west half of the Del Valle Bluffs and may be in part a duplication of the section exposed in the upper part of Blue Bluff. At the Del Valle Bluffs fault, described below, these ferruginous bands disappear.

Chalky stratum - Near the middle of the Del Valle Bluffs, a fault was encountered which has a throw to the east of nearly seventy-five feet. The fractured area of this fault has a horizontal range of about one hundred feet (See photograph on page nine). At the water level on the downthrow side, a four-foot stratum of indurated white clayey chalk was found containing an abundance of fossils. This stratum was also found in the east bank of the Colorado River one and one-tenth miles south of the Blue Bluff. From thirty feet below this ledge, the Taylor clay gradually grows less unctuous, and just beneath the ledge it becomes darker in color and more fissile. Above the ledge, the clay is also darker in color and more fissile than that below. Accompanying this change in lithology, the clay becomes more fossiliferous. These fossils reach the peak of their abundance in the ledge itself. The fossils below the chalk are of the smaller type, *O. falcata*, small fragile pelecypods and *Inocerami*. In the chalkey layer, these are present in abundance associated with an erratic variety of the *Exogyra costata*, *Helicoceras sp.*, *Pleurotoma sp.*, *Nautilus*, and *Gryphaea vesicularis*. It is believed that this stratum is a tongue of the

A view of the Chalky Stratum described on page 22.



A view of the North-facing Del Valle Bluffs west of above locality showing eastward dip of ferruginous layers.

Pecan Gap Limestone and other analogous chalk strata of the Northeast Texas Taylor marl.[4]

Gryphaea vesicularis zone - From the clayey chalk layer upward through a thickness of approximately seventy-five feet, the Taylor formation resembles the lower one hundred feet in lithological characteristics but contains the frequent remains of the Gryphaea vesicularis (Lamarck), Race A.[5] This zone is partly exposed in the Del Valle Bluffs. Another good exposure of the same zone will be found in the east side of a high round hill about two miles southwest of Manor. In this locality, one specimen of the E. costata was found, and evidently it is the same variety as found in the clayey chalk layer at the bottom of this section in the Del Valle Bluffs. Only two or three specimens of the E. ponderosa were found in this exposure at the very top of the hill. A similar association of G. vesicularis and E. ponderosa was

4. The Pecan Gap Limestone by Miss Ellisor; A. A. P. G. Bull., Dec., 1925
Also C. H. Dane and L. W. Stephenson; Notes on the Taylor and Navarro Formations in East-Central Texas; A. A. P. G. Bull., Vol. 12, No. 1, Jan., 1928.

5. Gardner: Upper cretaceous: Maryland Geol. Surv., 1916; p. 575, Pls XXIX and XXVIII.

found east of Pilot Knob and south of Moore and Berry's store, and it is believed that the combination of the two occurs at the top of the seventy-five feet of clay containing the *Gryphaea vesicularis*.

*The Helicoceras ledges* - Above the *G. Vesicularis* section the clay becomes less and less calcareous and more unctuous. About twenty-five feet above the last mentioned zone this unctuous clay contains ledges of nodular yellow limestone containing an abundance of the *Helicoceras navarroensis*. This section of nodular lime is about twenty-five feet in thickness. The ledges are not continuous, but along a certain stratum of the clay there will be found large nodules of yellow lime containing the above-mentioned fossil in abundance. These nodules when broken are found to contain veins of calcite and have a high content of iron near the center. They are concretionary in character. About five of these ledges occur in the twenty-five foot section. Other fossils usually found in these ledges are the *Sphenodiscus lenticularis*, *Placenticeras sp.*, *Suavagesia austinensis*, *Baculites ovatus*, *Microbacia sp.*, *Hamites Comanchensis*, large *Ostrea Falcata*, small pelecypods and gastropods. The Baculites of this horizon is the same species as that of the lower one-hundred foot section but in most cases it is much larger.

The *Helicoceras* ledges are well exposed in a creek about a mile and a half southeast of New Sweden Church, or one-half mile southeast of Sandahl's farm-house. The same ledges are exposed again one mile southeast of Manor in a cultivated field. Another good exposure may be found in Williamson County on Brushy Creek one mile west of Rice's Crossing in a bluff facing northwest.

*Bentonitic phase* - Above the *Helicoceras* ledges, the clay becomes more and more unctuous and less calcareous as seen in an exposure one mile south and one-half mile east of the Sandahl Farm exposure in the west bank of the same creek. This change is due, it is believed, to the increase in the amount of a material commonly called bentonite, which is thought to be a finely-divided, decayed volcanic ash. To say the least, there is an increase in the greenish-white color and the greasy consistency of the clay, both of which are characteristic of the bentonite. This increase culminates at the top of the Taylor marl section in a layer of pure bentonite. This pure material has a light greenish-white color and a very slick, greasy feeling. When dried in the sun or exposed to the atmosphere, it breaks up into very small pieces by cracking. When this dried material is soaked in water, it disintegrates completely by a fluffing-up process and becomes suspended in the water in microscopic particles.

In this lithologic division of the upper Taylor, which is about 40 feet in thickness, the E. ponderosa is found occasionally, increasing in abundance near the top. Associated with it, the E. Cancellata is found in greater abundance. Up to and including the Helicoceras ledges, the O. falcata is common. In the bentonitic phase, however, this fossil is very scarce even lacking in some parts of it, as are other species. A decrease in microscopic fossils was also noticed in this part of the section.

The exposure here discussed was found one-fourth of a mile west of Kimbro, seven miles northeast of Manor on the road to Elgin. Another exposure of part of the bentonitic phase may be found in Williamson County on the north side of Brushy Creek in a field gulley, one mile west of the Elgin-Taylor Highway.

Taylor-Navarro Contact Zone - The only actual exposure of the contact of the Taylor with the Navarro formation was found in the locality one-fourth of a mile west of Kimbro. Starting at the road one-fourth of a mile west from this place, and running north to a barn, there is a west-facing bank which is cut by deep gullies. In these gullies, exposures of the Taylor-Navarro Contact are encountered. These exposures, which are usually fresh, give a fair idea of the transition from Taylor marl to Navarro clay, there being visible about fifteen feet of the top and bottom of the respective formations. In its upper part, as already shown, the Taylor marl is a so-called bentonitic clay. At the contact, this bentonite is overlain by a chalky, sandy clay, the first six inches of which is in the form of a nodular, broken stratum. Covering this is a stratum of marly greenish-yellow clay about ten feet in thickness which is divided into two or three intervals by thin layers of harder material of the same character.

In the upper part of the Taylor marl, the E. ponderosa and E. Cancellata are common and extend upward through the section to the first nodular chalky layer where there is an abrupt change of species and the E. costata is present. The E. costata is common in the Navarro formation and this transition is believed to be the marker for the Taylor-Navarro contact when considered in connection

A view of the Taylor-Navarro contact described on page 28.

Another view of same contact as above.

with the change in lithology. Microscopic evidence was also found to support this idea. This will be discussed later.

At this locality, quite a bit of faulting was encountered which had a trend of N. 30° E. Apparently, the displacement was to the east but the throw could not be determined. Following this projected line to the southwest, faulting of a similar nature was found in a cultivated field three miles north and one mile east of Dunlap, about one-half mile west of the Dunlap-Manor road. E. costata was found on the east side of this fault, but E. ponderosa and E. cancellata occur on the west side. The throw is to the east. The displacement could not be exactly determined, but shortly east of the fault, fossils and sediments typical of the middle Navarro were found. This fact indicates a throw of two hundred feet or more. A line joining the Kimbro fault and the one north of Dunlap has a bearing of N. 30° E. and will project into Onion Creek south of the Colorado River, where it is suspected that a similar faulted condition exists.[6]

6. A cross section along the line AB and BC has been prepared in connection with the map in order to show the approximate faulted condition of the Taylor in that locality.

E Evidence of the latter is found in an exposure of Taylor marl seen in the west bank of Onion Creek two miles east of Del Valle on the road to Moore and Berry's store. This exposure is mapped by Hill and Vaughan in the Austin Folio as Navarro. Ferruginous layers and fossils, however, show it to be a part of the Blue Bluff section which is found in this locality on the account of faulting. Ferruginous layers of this character do not occur in the upper Taylor section. Also, at a point one-half mile east of this exposure (down Onion Creek from the crossing) in the north bank of the creek several springs were found issueing from the gravel, which is a good indication of a faulted condition. Exposures of the Taylor marl containing the <u>E. ponderosa</u> and <u>E. Cancellata</u> may be found farther down the creek to within one-fourth of a mile of the bridge on the main Del Valle-Bastrop highway. At this point exposures of clay containing glauconite in abundance were found and the disturbed, broken appearance of the formations lead one to believe that the Kimbro fault crosses at this point. The faulting must be of no small consequence for immediately north of the crossing of the Del Valle

Bastrop Highway on Onion Creek, a long bluff of typical Navarro clay is exposed. This exposure is in the east bank of the creek and is, on an average, seventy-five feet in total heighth. In this clay E. costata and Gryphaea vesicularis were found, the latter being of a race entirely different from those found in the Taylor marl.

## FORAMINIFERAL DATA

Since the contact of the Austin chalk with the Taylor marl is decidedly marked by the change in the lithology and the species of larger fossils, foraminiferal data would be of no special benefit in studying that horizon. But, in studying the Taylor-Navarro contact, it is advantageous to use this data since the transition is not so abrupt.

Samples were collected for this purpose during the time that the field work was being done. Besides the samples which were taken in the creek west of Kimbro for the study of the contact, other samples were taken at Manchaca Spring, Little Walnut Creek, east of Pilot Knob and at other points until it was felt that a representative set of samples of the Taylor formation was obtained. The samples at Blue Bluff and Del Valle Bluffs were taken every five and one-half feet, and the samples at the other localities were taken, as nearly as was possible, at the same intervals. This set of samples (about one hundred in number) has been washed carefully in the laboratory and examined for foraminiferal remains. The results of the first washing not being satisfactory, a second set were washed and examined.

On second examination, very good results were obtained and some excellent specimens of the Taylor foraminifera were found. The following is a list of the species identified from the field samples:

<u>Ammodiscus</u> <u>incertus</u> (d'Orbigny)
<u>Anomalina</u> <u>taylorensis</u> (Carsey)
<u>Anomalina</u> <u>grosserugosa</u> (Gumbel)
<u>Bigenerina</u> <u>nodosaria</u> (d'Orbigny)
<u>Bolivina</u> <u>latticea</u> (Carsey) or <u>Bolivinoides</u> <u>decorata</u> (Jones)
<u>Bolivina</u> <u>plaita</u> (Carsey)
<u>Bulimina</u> <u>compressa</u> (Carsey)
<u>Bulimina</u> <u>pupoides</u> (d'Orbigny)
<u>Cristellaria</u> <u>earlandi</u> (Plummer)
<u>Cristellaria</u> <u>gibba</u> (d'Orbigny)
<u>Cristellaria</u> <u>lineara</u> (Carsey)
<u>Cristellaria</u> <u>reniformis</u> (d'Orbigny) or <u>Lenticulina</u> <u>reniformis</u>
<u>Cristellaria</u> <u>rotulata</u> (Lamarck) or <u>Lenticulina</u> <u>rotulata</u>
<u>Cristellaria</u> <u>scitula</u> (Berthelin)
<u>Cristellaria</u> <u>trigonata</u> (Plummer)
<u>Clavulina</u> <u>angularis</u> (d'Orbigny)

Cibicides refulgens (Montfort) or
Truncatulina refulgens. Var. conica (Carsey)[7]
Discorbis correcta (Carsey)
Frondicularia alata (d'Orbigny)
Frondicularia archiaciana (d'Orbigny)
Frondicularia christneri (Carsey)
Frondicularia projecta (Carsey)
Gaudryina atlantica (Bailey)
Gaudryina bulleta (Carsey)
Gaudryina filiformis (Berthelin)
Gaudryina pupoides (d'Orbigny)
Globigerina cretacea (d'Orbigny)
Globigerina rosetta (Carsey)
Globotruncana arca (Cushman)
Gyroidina soldani (d'Orbigny)
Haplophragmoides sp -- resembles H.
canariensis (d'Orbigny)
Haplostiche sp.
Lagena hespida (Reuss)
Lagena incidenta (Carsey)
Lagena Sulcata (Walker and Jacob)
Lituola nautifoidea (Lamarck)
Marginulina glabra (d'Orbigny)
Marginulina regularis (d'Orbigny)
Marginulina tumida (Reuss)
Nodosaria affins (d'Orbigny)
Nodosaria alternata (Carsey)
Nodosaria communis (d'Orbigny)
Nodosaria comata (Batsch)
Nodosaria farcimen (Soldani)
Nodosaria filiformis (d'Orbigny)
Nodosaria fragilis (Carsey)
Nodosaria granti (Plummer)
Nodosaria intrasegma (Carsey)
Nodosaria longiscata (d'Orbigny)
Nodosaria marla (Carsey)
Nodosaria mucronata (Neugeboren)
Nodosaria pauperata (d'Orbigny)
Nodosaria pseudo-obliquestriata (Plummer)
Nodosaria soluta (Reuss)
Nodosaria radicula (Linnaeus) or N. larva (Carsey)

7. This species is a type fossil of the Taylor marl, not being found in the formations below or above it.

*Nodosaria texana* (Conrad)
*Nodosaria vertebralis* (Batsch) *Var. austinensis* (Carsey)
*Pleurostomella sp.*
*Robulus cultratas* (Montfort) -- *Cristellaria cultrata*
*Rotalia cretacea* (Carsey)
*Rotalia soldanii* (d'Orbigny). *Var. subangulata* (Plummer)
*Textularia globifera* (Reuss)
*Textularia globulosa* (Ehrenberg)
*Textularia semicomplanata* (Carsey)
*Tritaxis tricarinata* (Reuss)
*Vaginulina legumen* (Linnaeus)
*Vitrewebbina sollasii* (Chapman)[8]

This list of sixty-seven species is not a complete one of the foraminifera of the Taylor formation as there are some fifteen species as yet not identified due to the lack of literature on the subject.

For further data on the foraminifera of the Taylor marl a set of well samples was examined. It is possible that these well samples give an accurate distribution of the species throughout the section. The well is located in Bell County, and the data from it show a thickness of about five hundred and fifty feet in the Taylor, which is the same as in Travis County.

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8. The species included in this list were identified from the following bulletins:
Carsey - Foraminifera of the Cretaceous of Central Texas; Plummer - Foraminifera of the Midway Formation of Texas: Cushman - Contributions: The Challenger Report: A set of two hundred species of foraminifera loaned by Mr. Robert F. Cuyler, of The University of Texas, Department of Geology.

The hole was started practically at the contact of the Taylor and Navarro and went into Austin chalk at six hundred and twenty feet. Fifty-five samples from this well are available for examination. The following is a list of the foraminifera in each sample given in descending order with the corresponding depth of each sample from the top of the well.

## Foraminifera from the R. R. Penn -- Hardy #1

## Bell County, Texas

Sample #1, 40' in depth

*Globigerina rosetta*
*Globigerina cretacea*

#2, 70'
*Textularia globulosa*
*Globigerina cretacea*
*Globigerina rosetta*
*Anomalina taylorensis*
*Cristellaria rotulata*
*Frondicularia projecta*
*Frondicularia christneri*
*Clavulina angularis* ?

#3, 95'
*Globigerina rosetta*
*Globigerina cretacea*
*Textularia globulosa*
*Truncatulina refulgens*

#4, 105'
*Globigerina rosetta*
*Globigerina cretacea*
*Anomalina taylorensis*
*Cristellaria rotulata*

#5, 125'
*Cristellaria lineara*
*Anomalina grosserugosa*
*Bulimina pupoides*
*Nodosaria marla*
*Nodosaria farcimen*
*Truncatulina refulgens*
*Textularia globulosa*
*Globigerina rosetta*
*Globigerina cretacea*
*Anomalina taylorensis*
*Cristellaria rotulata*
*Tritaxia tricarinata*

#6, 135'

*Cristellaria reniformis*
*Anomalina grosserugosa*
*Nodosaria intrasegma*
*Lagena incidenta*
*Truncatulina refulgens*
*Globigerina rosetta*
*Anomalina taylorensis*
*Cristellaria rotulata*
*Tritaxia tricarinata*
*Nodosaria texana*
(Microscopic, spherical body studded with short nodes; probably *Ramulina sp.*?)

#7, 145'
*Frondicularia alata*
*Vaginulina sp.*
*Nodosaria sp.*
*Anomalina grosserugosa*
*Bolivina plaita*
*Bulimina pupoides*
*Lagena incidenta*
*Truncatulina refulgens*
*Bolivina latticea*
*Globigerina cretacea*
*Globigerina rosetta*
*Anomalina taylorensis*
*Cristellaria rotulata*
*Tritaxia tricarinata*
*Nodosaria texana*
*Textularia sp.*
*Nodosaria communis*
*Nodosaria filiformis*
*Clavulina angularis* ?

#8, 155'
*Frondicularia alata*
*Anomalina grosserugosa*

Textularia semicomplanata
Lagena incidenta
Nodosaria sp.
Truncatulina refulgens
Bolivina latticea
Textularia globulosa
Globigerina rosetta
Globigerina creatcea
Anomalina taylorensis
Cristellaria rotulata
Tritaxia tricarinata
Frondicularia projecta
Textularia sp.
Clavulina angularis ?

#9, 165'
Frondicularia alata
Anomalina grosserugosa
Truncatulina refulgens
Textularia globulosa
Globigerina rosetta
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata
Tritaxia tricarinata
Frondicularia projecta
Nodosaria texana

#10, 175'
Frondicularia alata
Nodosaria larva
Nodosaria alternata
Truncatulina refulgens
Globigerina rosetta
Cristellaria gibba
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata
Tritaxia tricarinata
Frondicularia christneri
Nodosaria texana
Frondicularia sp.

#11, 180'
Frondicularia alata
Anomalina grosserugosa
Trucatulina refulgens
Globigerina rosetta
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata
Tritaxia tricarinata
Nodosaria texana
Clavulina angularis ?
Frondicularia sp.

#12, 184'
Anomalina grosserugosa
Bolivina plaita
Bulimina pupoides
Textularia globulosa
Globigerina rosetta
Cristellaria gibba
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata
Tritaxia tricarinata
Frondicularia projecta
Gaudryina filiformis

#13, 194'
Nodosaria marla
Nodosaria farcimen
Truncatulina refulgens
Textularia globulosa
Globigerina rosetta
Anomalina taylorensis
Cristellaria rotulata
Tritaxia tricarinata
Nodosaria texana

#14, 194'
Nodosaria larva
Anomalina grosserugosa
Textularia semicomplanata
Gaudryina pupoides
Gaudryina bulleta
Lagena incidenta
Nodosaria laevigata
Truncatulina refulgens
Textularia globulosa
Globigerina rosetta
Cristellaria gibba
Anomalina taylorensis

Cristellaria rotulata
Tritaxia tricarinata
Nodosaria texana
Clavulina angularis ?

#15, 205'
Nodosaria larva
Nodosaria sp.
Nodosaria sp.
Anomalina grosserugosa
Textularia semicomplanata
Gaudryina pupoides
Lagena incidenta
Textularia globulosa
Globigerina rosetta
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata
Tritaxia tricarinata
Frondicularia christneri
Frondicularia projecta
Nodosaria texana
Nodosaria communis

#16, 215'
Nodosaria larva
Nodosaria sp.
Anomalina grosserugosa
Textularia semicomplanata
Bolivina plaita
Gaudryina bulleta
Nodosaria farcimen
Lagena incidenta
Globigerina rosetta
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata
Tritaxis tricarinata
Frondicularia projecta
Frondicularia christneri
Nodosaria texana
Lagena sulcata
Nodosaria communis

#17, 225'
Nodosaria larva
Nodosaria sp.
Anomalina grosserugosa
Textularia semicomplanata
Bolivina plaita
Nodosaria farcimen
Lagena incidenta
Globigerina rosetta
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata
Tritaxia tricarinata
Frondicularia projecta
Nodosaria communis
Clavulina aungularis ?
Truncatulina refulgens

#18, 235'
Cristellaria lineara
Nodosaria sp.
Nodosaria sp.
Anomalina grosserugosa
Textularia semicomplanata
Globigerina cretacea
Globigerina rosetta
Nodosaria fragilis
Bolivina plaita
Bulimina pupoides
Gaudryina bulleta
Nodosaria marla
Textularia globulosa
Bolivina latticea
Anomalina taylorensis
Cristellaria rotulata
Tritaxia tricarinata
Frondicularia christneri
Nodosaria texana
Clavulina angularis ?
Frondicularia projecta

#19, 245'
Nodosaria sp.
Anomalina grosserugosa
Textularia semicomplinata
Nodosaria alternata
Bolivina latticea
Textularia globulosa

Globigerina rosetta
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata
Tritaxia tricarinata
Frondicularia christneri
Nodosaria communis
Clavulina angularis ?

#20, 255'
Nodosaria larva
Nodosaria sp.
Textularia semicomplinata
Nodosaria marla
Bolivina latticea
Textularia globulosa
Globigerina rosetta
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata
Tritaxia tricarinata
Nodosaria vertebralis

#21, 265'
Textularia semicomplinata
Nodosaria marla
Textularia globulosa
Globigerina rosetta
Globigerina cretacea
Cristellaria rotulata
Frondicularia projecta

#22, 272'
Anomalina grosserugusa
Textularia globulosa
Globigerina rosetta
Globigerina cretacea
Tritaxia tricarinata
Clavulina angularis ?

#23, 275'
Nodosaria marla
Nodosaria alternata
Anomalina taylorensis
Cristellaria rotulata
Tritaxia tricarinata
Frondicularia christneri
Clavulina angularis ?

#24, 285'
Gaudryina bulleta
Textularia globulosa
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata
Cristellaria gibba
Tritaxia tricarinata
Frondicularia christneri

#25, 295'
Globigerina rosetta
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata
Clavulina angularis ?

#26, 305'
Textularia globulosa
Globigerina rosetta
Globigerina cretacea
Anomalina taylorensis
Tritaxia tricarinata
Clavulina angularis ?

#27, 335'
Gaudryina pupoides
Textularia globulosa
Globigerina rosetta
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata

#28, 345'
Textularia globulosa
Cristellaria gibba
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata
Tritaxia tricarinata
Nodosaria texana
Clavulina angularis ?

#29, 355'
Textularia globulosa

Anomalina taylorensis
Cristellaria rotulata
Tritaxia tricarinata
Frondicularia projecta
Nodosaria texana

#365'
Textularia semicomplanata
Bulimina pupoides
Cristellaria gibba
Nodosaria texana

#31, 375'
Textularia globulosa
Cristellaria gibba
Anomalina taylorensis
Cristellaria rotulata

#32, 385'
Bolivina plaita
Textularia globulosa
Anomalina taylorensis
Cristellaria rotulata

#33, 390'
Globigerina rosetta
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata

#34, 390'
Textularia globulosa
Globigerina rosetta
Globigerina cretacea
Anomalina taylorensis

#35, 415'
Textularia semicomplanata
Nodosaria marla
Globigerina rosetta
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata
Tritaxia tricarinata
Nodosaria texana

#36, 420'
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata

#37, 430'
Textularia globulosa
Globigerina rosetta
Globigerina cretacea
Cristellaria rotulata
Nodosaria texana

#38, 440'
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata
(small gastropod)

#39, 450'
Globigerina rosetta
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata

#40, 460'
Textularia globulosa
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata
Frondicularia projecta

#41, 470'
Gaudryina pupoides
Textularia globulosa
Globigerina rosetta
Globigerina cretacea
Cristellaria rotulata

#42, 480'
Bolivina plaita
Textularia globulosa
Globigerina cretacea
Anomalina taylorensis
Cristellaria routlata
Frondicularia projecta

#43, 490'
Nodosaria alternata
Textularia globulosa
Globigerina rosetta

Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata
Tritaxia tricarinata
Frondicularia christneri
Nodosaria texana
Frondicularia sp.

#44, 500'
Bolivina plaita
Textularia globulosa
Globigerina rosetta
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata
Frondicularia christneri
Nodosaria texana

#45, 510'
Globigerina rosetta
Globigerina cretaces
Anomalina taylorensis
Cristellaria rotulata
Tritaxia tricarinata
Frondicularia projecta

#46, 520'
Globigerina rosetta
Globigerina cretacea
Textularia globulosa
Anomalina taylorensis
Cristellaria rotulata
Tritaxia tricarinata
Frondicularia christneri

#47, 530'
Globigerina rosetta
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata

#48, 540'
Bolivina plaita
Bulimina pupoides
Textularia globulosa
Globigerina rosetta
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata

#49, 550'
Textularia globulosa
Globigerina rosetta
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata
Nodosaria communis

#50, 560'
Globigerina rosetta
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata
Frondicularia christneri

#51, 580'
Textularia globulosa
Globigerina rosetta
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata
Frondicularia christneri

#52, 590'
Bulimina pupoides
Nodosaria marla
Nodosaria alternata
Textularia globulosa
Globigerina rosetta
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata
Tritaxia tricarinata
Frondicularia projecta
Ammodiscus incertus

#53, 600'
Bolivina plaita
Textularia globulosa
Globigerina rosetta
Globigerina cretacea
Anomalina taylorensis

Cristellaria rotulata
Tritaxia tricarinata
Frondicularia christneri
Ammodiscus incertus

#54, 610'
Nodosaria marla
Textularia globulosa
Globigerina rosetta
Globigerina cretacea
Anomalina taylorensis
Cristellaria rotulata
Frondicularia christneri
Frondicularia sp.
Ammodiscus incertus

#55, 620'
Bulimina pupoides
Textularia globulosa
Globigerina rosetta
Anomalina taylorensis
Cristellaria rotulata
Tritaxia tricarinata

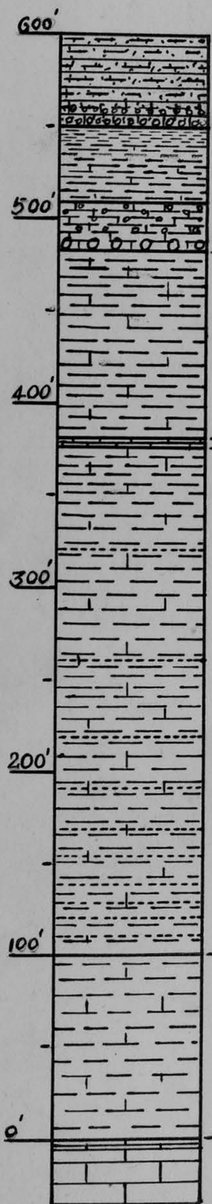
The information obtained from this set of samples will be found to be of no great value other than a good index to the distribution of the common species throughout the Taylor section, since the slides available for inspection apparently did not contain all of the species that might be found in the Taylor marl.

The data obtained from a study of the field samples affords several important facts to be noted. First, that Truncatulina refulgens is a type fossil of the Taylor marl, since it is not present in any other formation of the Comanchean or Gulf Series of the Cretaceous. Second, that so far as known, Lituola nautifoidea is not found in any horizon of the Taylor other than the four-foot stratum of clayey chalk exposed in the Del Valle Bluffs of the Colorado River. This should be a definite marker for subsurface investigations. Third, that the change in lithology and larger fossils, found at the Taylor-Navarro contact, is accompanied by a similar change in micro-faunal remains. This is shown in the fact that below the contact, Taylor fossils are present while above the contact these disappear and typical Navarro species such as Vaginulina webbervillensis and Polymorphina communis are found.

AN APPROXIMATE TAYLOR MARL SECTION

DETERMINED FROM FIELD DATA

Scale 1" = 100'




Navarro: *Exogyra costata*, *Vaginulina webbervillensis*, *Polymorphina communis*.

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Bentonitic clay: *Exogyra* ~~*cancellata*~~, *E. ponderosa*, Upper ten feet very bentonitic.

Unctuous clay and nodular limestone strata: *Helicoceras navarroensis* abundant.

Massive blue marl: *Gryphaea vesicularis* in lower half.

Clayey chalk: Upper one-foot hard and fossiliferous *E. costata* var. ?, *Lituola nautifoidea*.

Massive blue marl containing two-inch layers of Ferruginous material not regularly spaced. (more abundant in lower part.)

Massive blue marl: Frequent specimens of *E. ponderosa* present (rounded type) at the top of which is found a one-foot stratum of *Baculites oratus* casts. First *Ostrea Falcata* appears at base with *Gryphaeaostrea* sp. (aff. G. *Vomer*.)

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Massive glaring white Austin chalk or limestone. E. ponderosa present (angular type). No *O. falcata* present.

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Geology from Austin Folio with emendments
by
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